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United States Department of Agriculture
Agricultural Research ServiceUSE OF IMMATURE APPLES FOR REARING
THE ORIENTAL FRUIT MOTHBy H. W. Allen, Entomology Research Branch^{1/}

A satisfactory supply of food is a primary requirement for any laboratory work for which an insect is reared. At the Moorestown, N.J., laboratory, small green apples picked late in June by growers thinning their fruit have been used for many years in rearing the oriental fruit moth (*Grapholitha molesta* (Busck)). These apples are sorted and packed with a copious amount of oiled shredded paper in 32-quart bean hampers (fig. 1), and placed immediately in commercial cold storage at apple storage temperatures (32-35° F.). The apples decompose more slowly in this pack than when they are stored in bushel baskets without shredded paper. In New Jersey Golden Delicious is one of the varieties most likely to be thinned, and immature apples of this variety can be kept in storage longer than those of other common varieties. Storage in chambers cooled by expansion coils in which short periods of frosting and defrosting alternate is not satisfactory for long storage, as it desiccates the apples and causes them to wither.

Apples packed and stored late in June are generally satisfactory for use until the following June. However, when rot begins to show up after several months of storage, it has been found feasible to sort out and discard the paper and all decaying fruit, and to wash all sound apples in wettable surfur (1 ounce to 1 gallon of water) and repack them in fresh shredded paper while still wet.

As long as lead arsenate was the principal insecticide in apple spray programs, residues were readily removed by washing in a bath of 1-percent hydrochloric acid. The present widespread use of DDT or parathion on apple results in residues that cannot be removed without injury to the fruit. This has greatly increased the difficulty of obtaining supplies of apples suitable for use in rearing the oriental fruit moth and its parasites. Unsprayed apples are usually diseased and heavily infested with insects and do not store well. Spraying trees with lead arsenate may be a bothersome and expensive means of obtaining the needed supplies.

^{1/} Assisted by E. L. Plasket.

In 1953 it was found^{2/} that a solvent containing benzene, isopropyl, alcohol, and Tween 20^{2/} would reduce DDT residues enough to make the apples usable in rearing work. Benzene is a better solvent than isopropyl alcohol for the chlorine and phosphorus insecticides, but it damages the tissue of the fruit more. The damage consists of brown pitted areas just beneath the skin (fig. 2). When the pits are 1 mm. or less in diameter, treated fruit can be held for several weeks after washing. It was found after testing several formulations that good solvent action and relatively low damage were obtained with a mixture containing 20 parts of benzene to 80 parts of 99-percent isopropyl alcohol (by volume), to which 60 grams of Tween 20 per liter was added.

The washing is done outdoors or in a well-ventilated shelter, preferably when the temperature of the solvent is 70-80° F. Heavy neoprene gloves protect the skin from the residue-contaminated solvent. Five earthenware crocks are used in the washing and rinsing (fig. 3). The first two are two-thirds filled with the solvent, each from a separate carboy and provided with metal covers; the other three are filled with water. The apples are placed in a cylindrical basket with a cover made of heavy screen wire and mounted on a broom handle to act as a plunger. The basket should be about half as tall as the crock and slightly less than its diameter. The basket containing apples is worked vigorously up and down in the first jar of solvent for 10 seconds, then quickly transferred to the second jar for a second washing of 10 seconds, drained quickly, and emptied into the first rinse. The whole exposure to solvents should not take much more than 30 seconds, particularly if the temperature of the solvent is above 80° F. In the rinse the apples are agitated and ladled from one crock to another, and finally to racks, where they are left for an hour or two until dry and free of benzene fumes. After drying, the apples if kept in cold storage will remain suitable for rearing work for several weeks. The solvent may be used for many washes. When the first wash becomes befouled with trash, dirt, and precipitated material, it is replaced with fresh solvent, and exchanged with the second wash, now moved up to the first position. The rinses are rotated in the same manner, the changes being made frequently so that the third rinse is always free of soapy bubbles.

In 1953 numerous tests were made with immature apples obtained from orchards sprayed with DDT. It was found that unwashed apples having DDT residues were very toxic to adults of the oriental fruit moth parasites Horogenes molestae (Uchida) and Macrocentrus ancylivorus Roh., and moderately so to Phanerotoma grapholithae Mues. and Agathis

^{2/} The author requested R. D. Chisholm and Louis Koblitsky of the Pesticide Chemicals Research Section to suggest a solvent which would remove DDT residues from immature apples. They prepared the mixture described above which was tested by the author.

festiva Mues., as well as to the oriental fruit moths. When adults of these species were exposed to apples washed as described above, there was no greater mortality than in the check lots exposed to unsprayed apples. The propagation of oriental fruit moths and their parasites exposed to washed apples was as high as in the no-spray checks. During the many months that apples with DDT residues have been washed by this process and used in routine parasite production, there has been no evidence of objectionable toxicity.

On apples picked 4 days after being sprayed with parathion and placed in commercial cold storage, highly toxic residues persisted for many months and the apples proved generally undesirable for rearing work. There was a high mortality among oriental fruit moths and several species of parasites of the fruit moth when exposed with unwashed apples. The washing procedure that served to reduce DDT to tolerated levels failed to do so with parathion residues. After 32 weeks of storage these parathion-sprayed apples were analyzed, and small but detectable residues of parathion were found. Samples were given the customary 30-second wash in benzene-isopropyl alcohol. These apples were used in propagating A. festiva and P. grapholithae, and there was no evidence of toxicity to the breeding parasites. However, when oriental fruit moths were exposed with the washed apples in egg-deposition cages, there was a high mortality, which did not appear until after 96 hours of exposure.



Figure 1.--Bean hamper with small green apples packed for long storage.



Figure 2.--Apples that have been washed in benzene-isopropyl alcohol to remove residues of DDT.



Figure 3.--Washing apples in benzene-alcohol mixture.

